



**University of Idaho**

College of Engineering

# **VIRTUAL FENCE SYSTEM DESIGN**

## **TEAM SHOCK'EM**

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# BEEF CATTLE INDUSTRY IN IDAHO



## Why it is important:

- Valued at \$1.5 billion
- Over 2 million cows and calves
- 2<sup>nd</sup> largest economic sector in our state





**Barbed Wire**

### **Disadvantages of Barbed Wire:**

- Cost is very high
- Can injure animals
- Requires regular maintenance



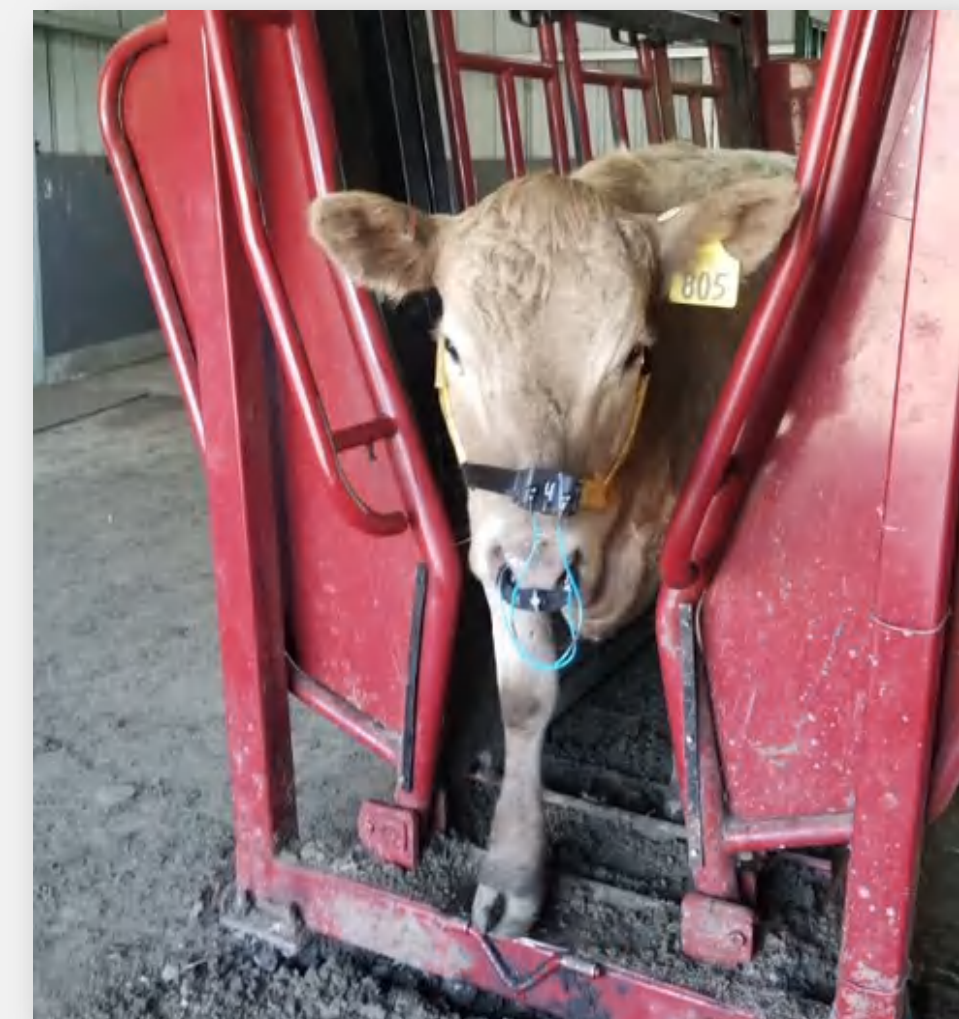
**Current Virtual Fence Devices**

### **GPS-Based Virtual Fence Limitations:**

- Expensive
- Heavy device on animal
- May require monthly subscription

# VALUE PROPOSITION

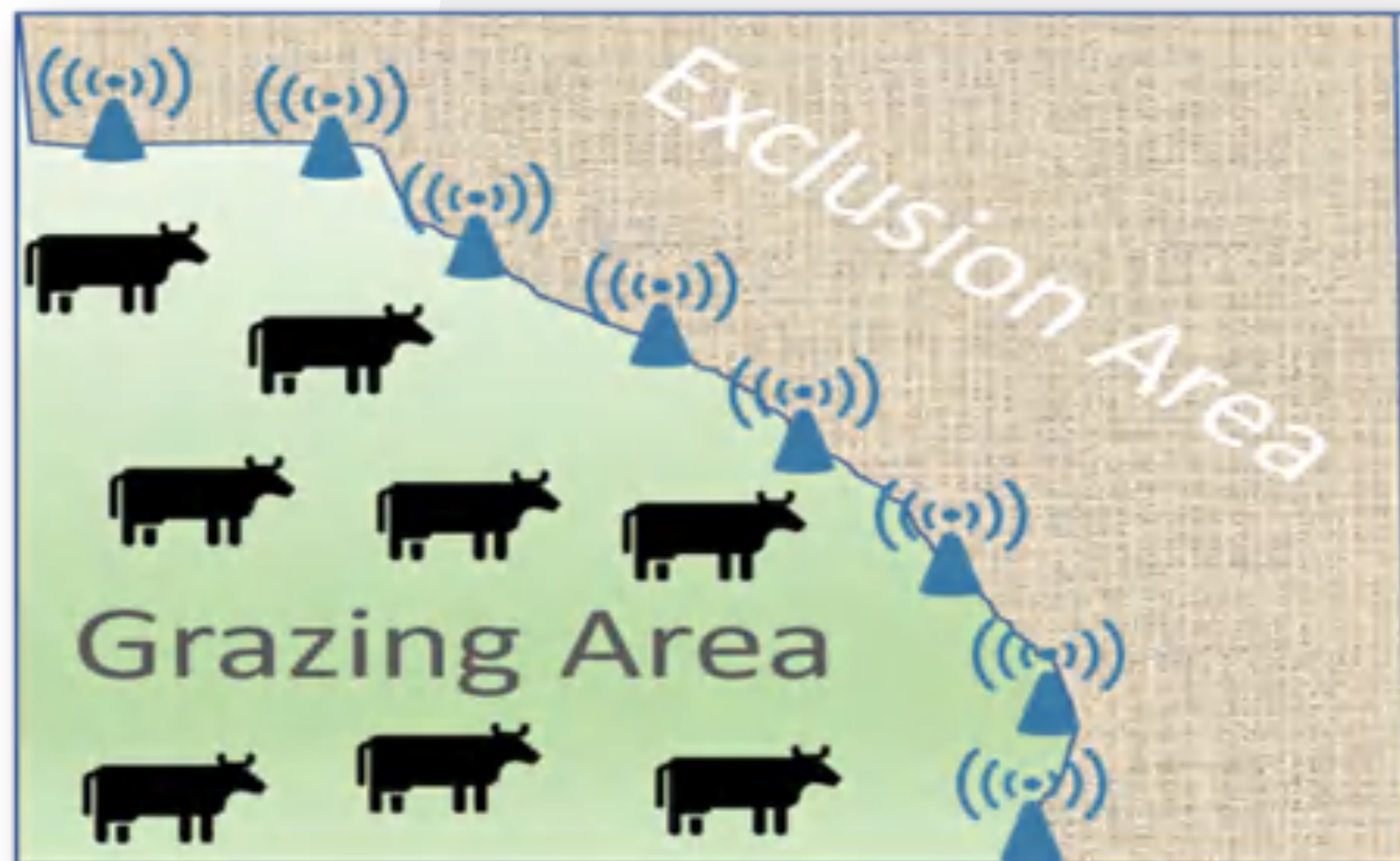
- I Current virtual fencing attempts rely on **bulky, power-hungry, GPS-based systems** with **limited scalability** for typical range livestock operations in Idaho and the West due to expense and connectivity requirements.
- I This project aims to **reduce costs and power requirements** by locating cows using signals between local beacons, and administering a shock to the animal via a device in their ear tag.



# OBJECTIVE

OUR GOAL FOR THE PROJECT WAS TO DESIGN A SYSTEM THAT:

- I Can locate and identify rangeland cattle without using GPS
- I Creates a virtual fence using physical beacons as visuals that also act as visual cues
- I Buzzes the cow first, then shocks the cow to train them where the fence is



# PRODUCT REQUIREMENTS

## I Permanent Beacons

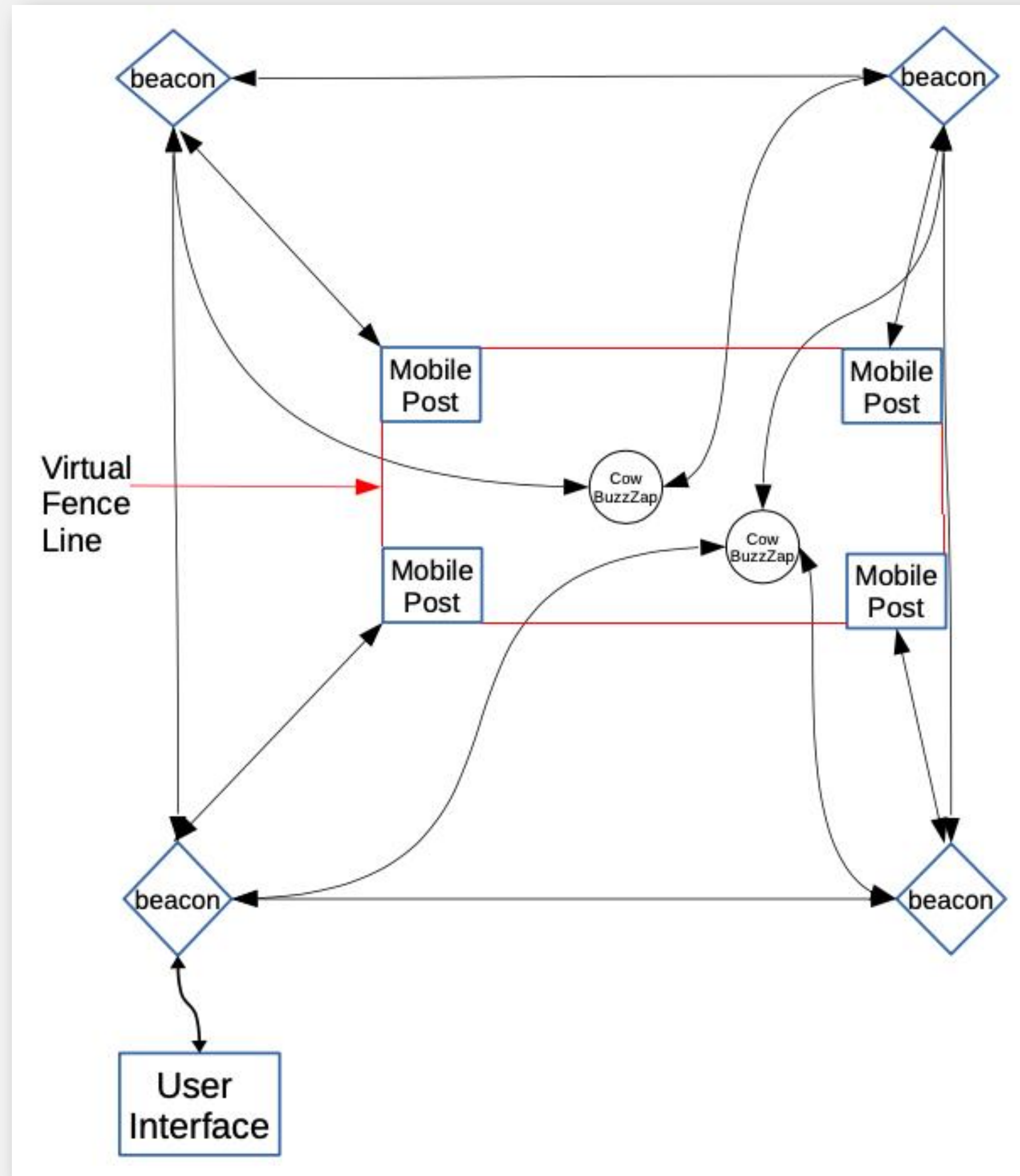
- Know their own position
- Locate Cows and Fence Line

## I Mobile Fence Posts

- Mark the fence line

## I Ear Tag Device

- Buzz cow
- Zap cow
- Long battery life



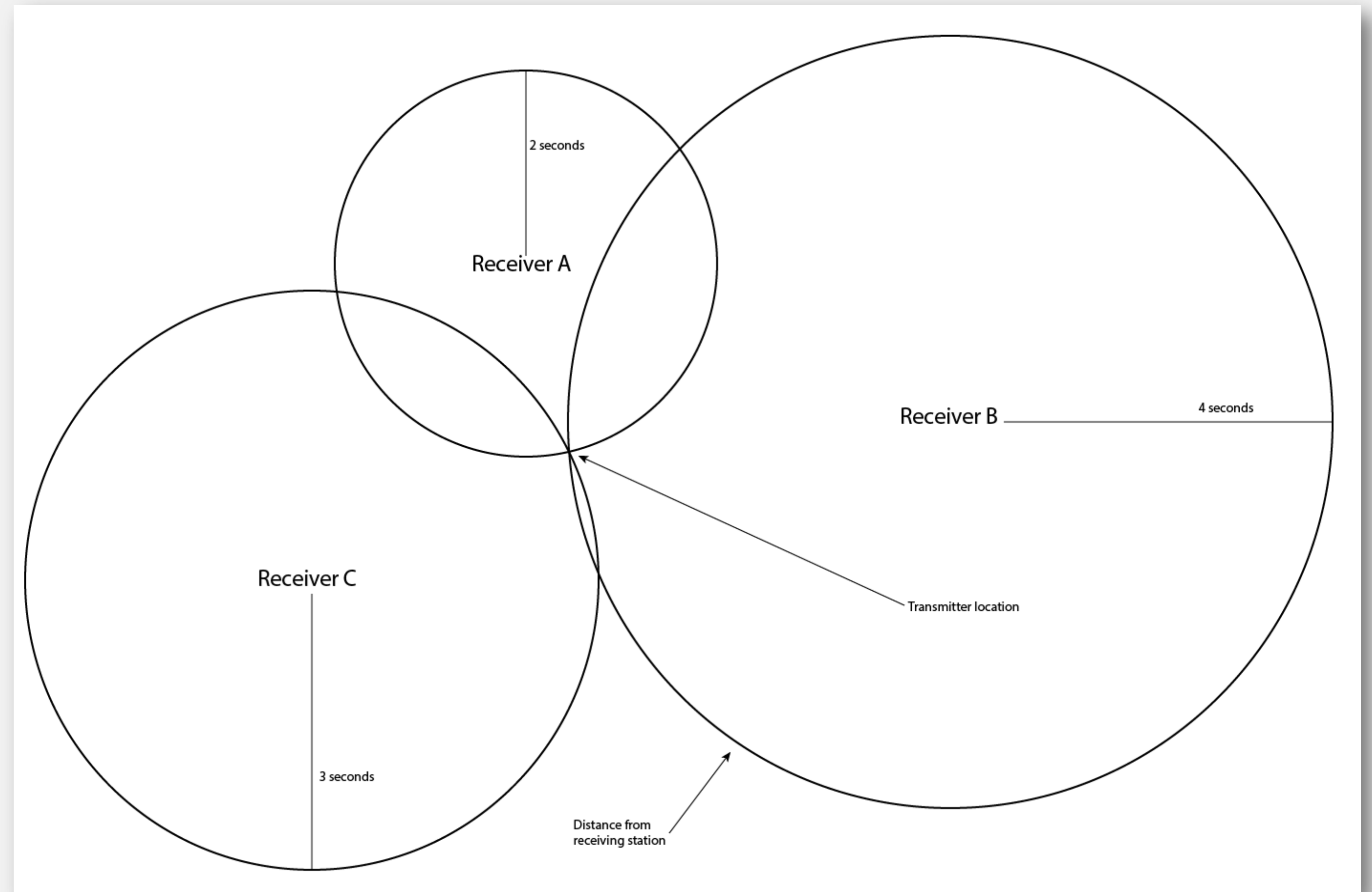
System Diagram

# TRILATERATION

Allows for error from

- Exact location of receiver
- Distance from receiver

Beacons can be at any position

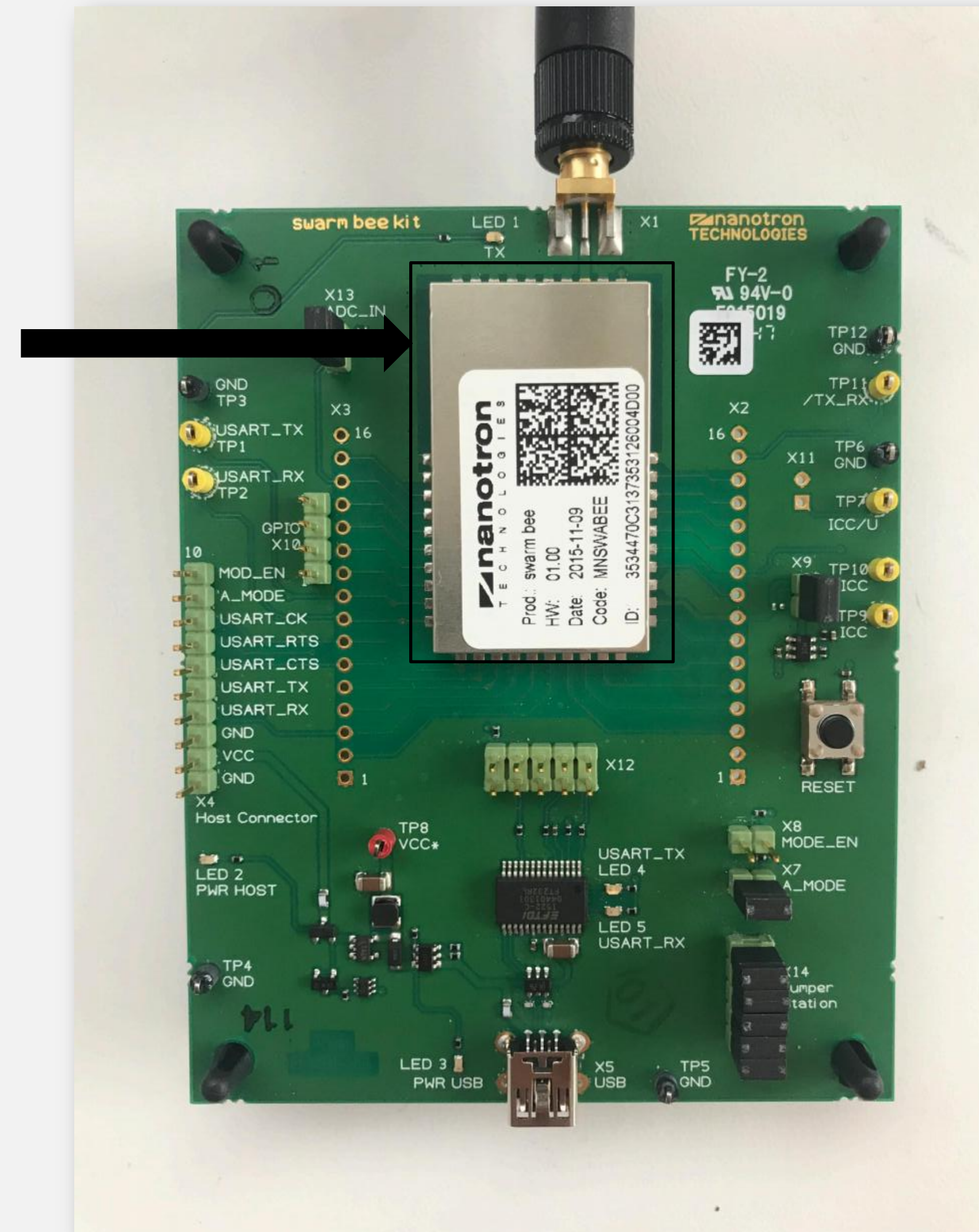


# NANOTRON DEVICES



- I** Measure distance based on time of flight
- I** 500m range
- I** Operates at 2.4 GHz (ZigBee/WiFi)
- I** 3.3 V, 120 mA
- I** Low Power Options

Nanotron Module



## DISTANCE TESTS

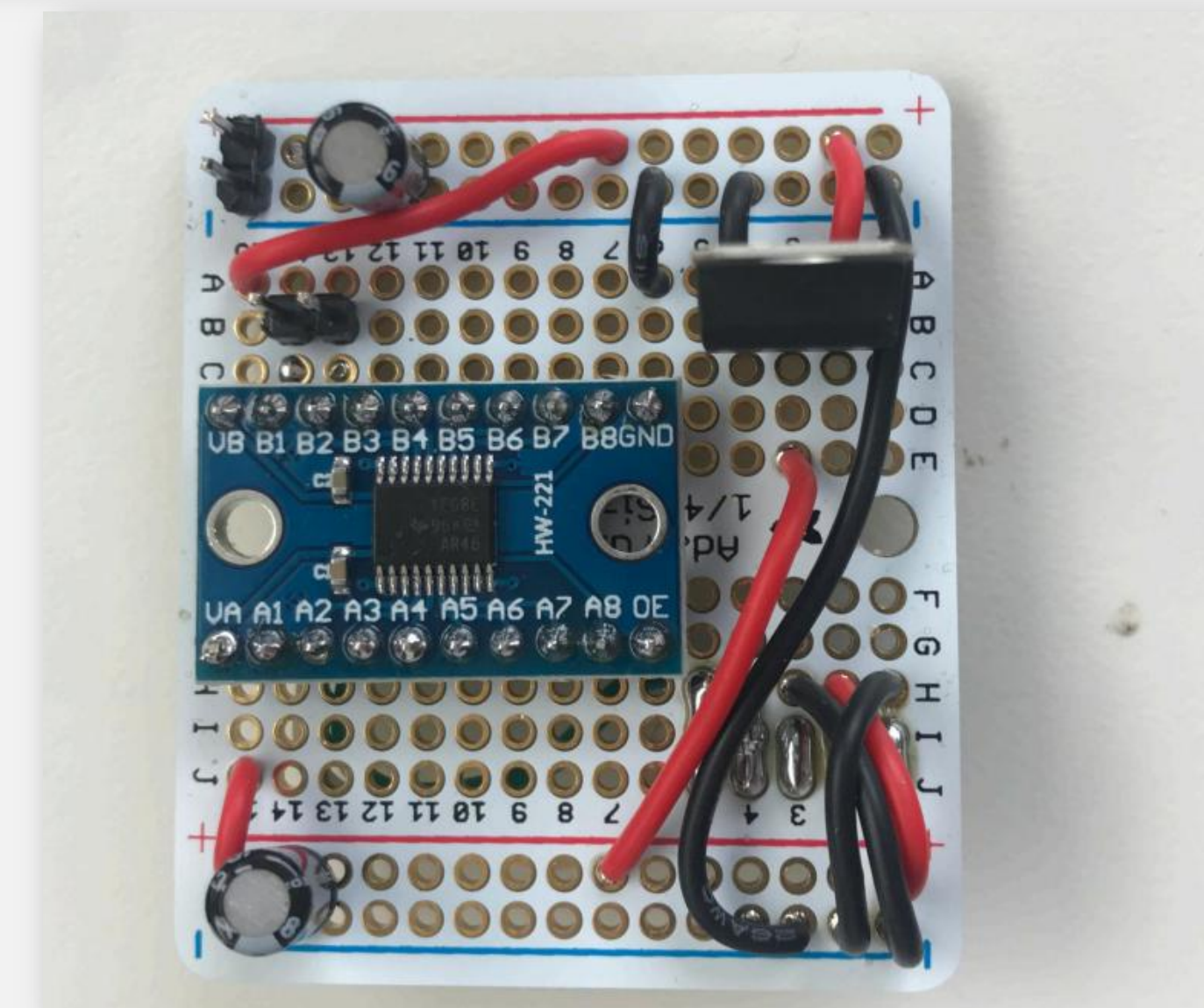
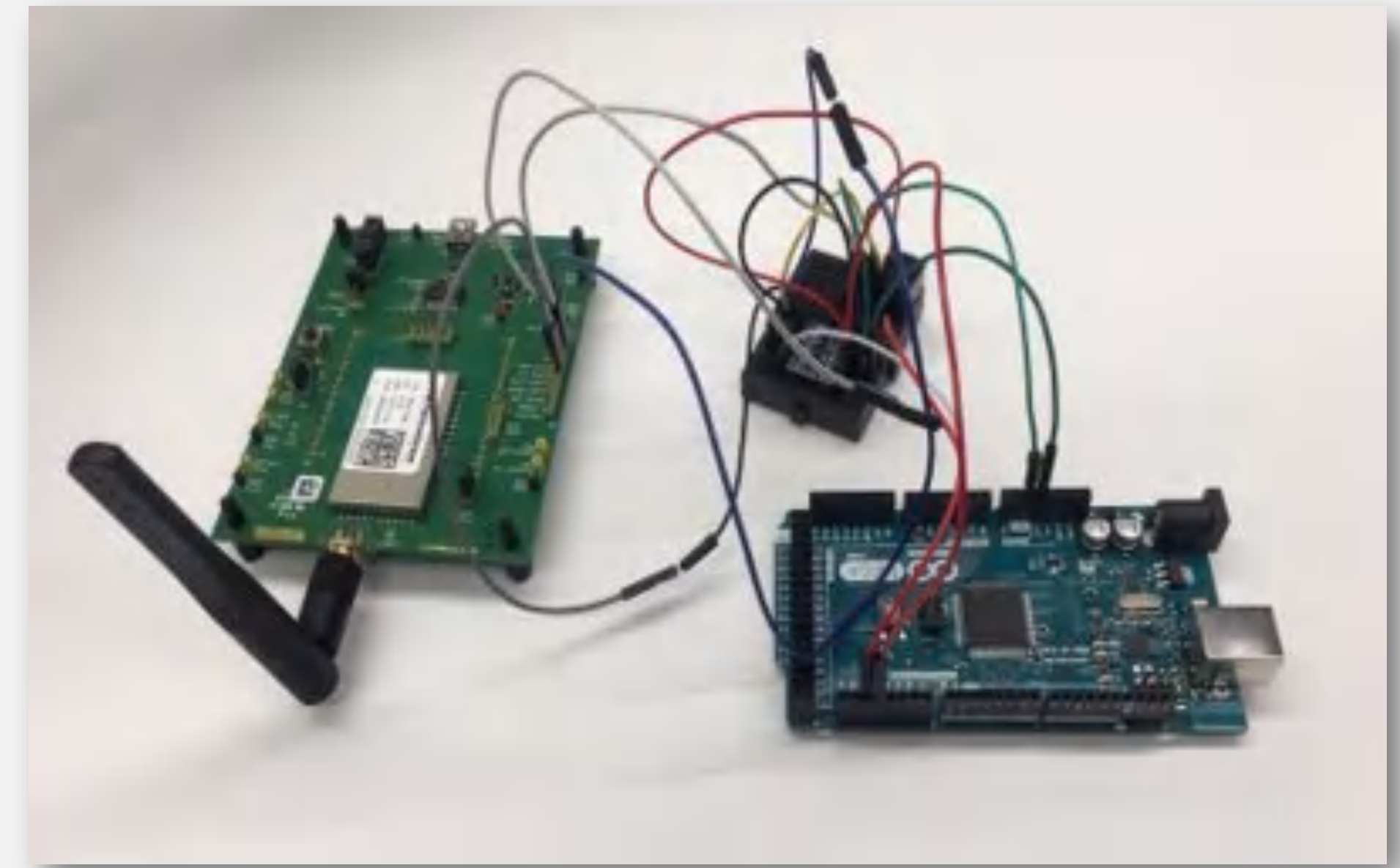
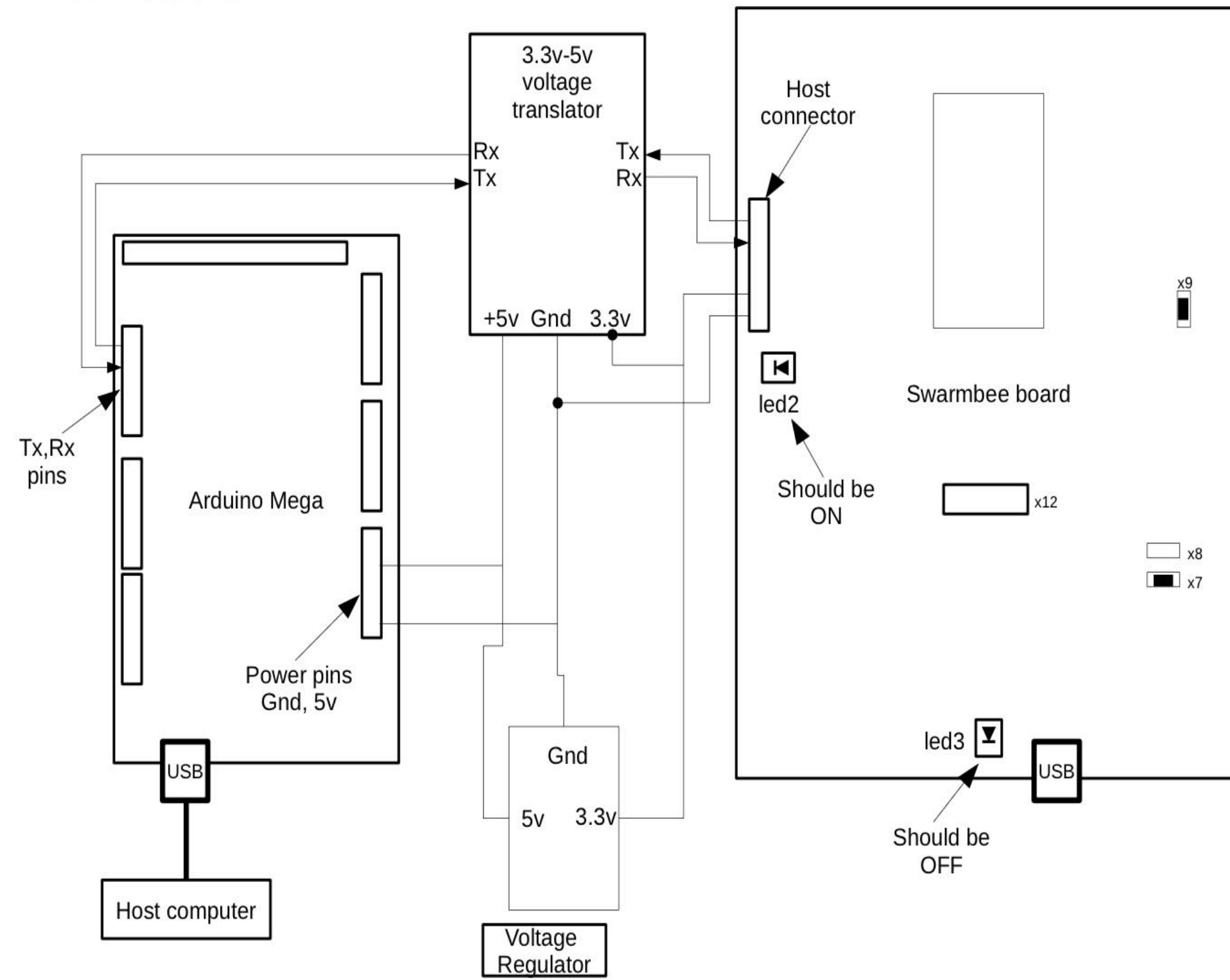
D (actual)(m)	D (measured)(m)	Error (%)
3	5.6	86.6667
10	13.5	35
30	32.9	9.66667
40	41.5	3.75
50	50.78	1.56



# NANOTRON TO MICROCONTROLLER SETUP



Nanotron to Arduino Connections



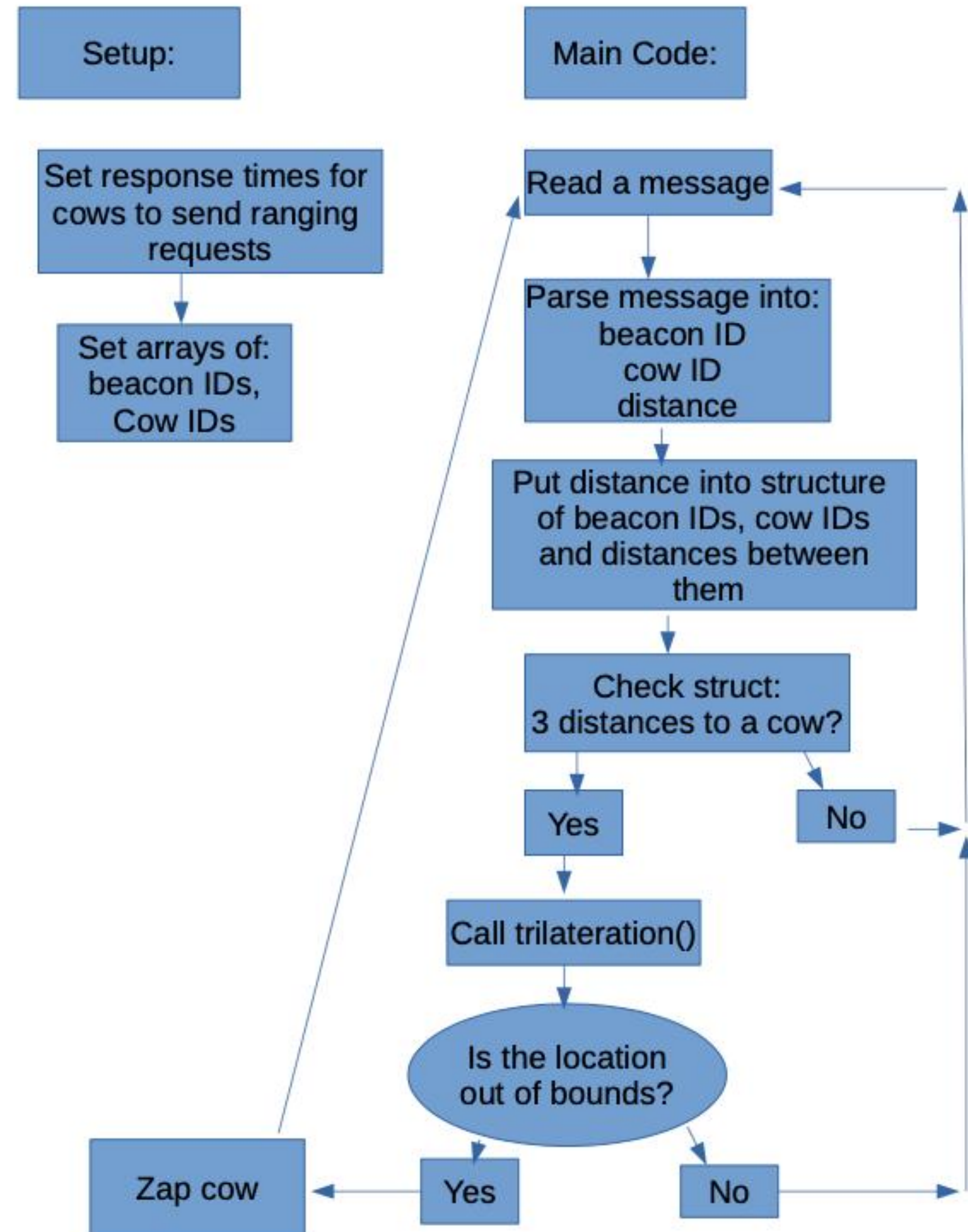
# NANOTRON SOFTWARE

```
*RRN:000025DEE6B,000112A7CCA,0,00092,0004,-35  
ID1 = 000025DEE6B  
ID2 = 000112A7CCA  
distance = 00092 centimeters  
RSSI = -35
```

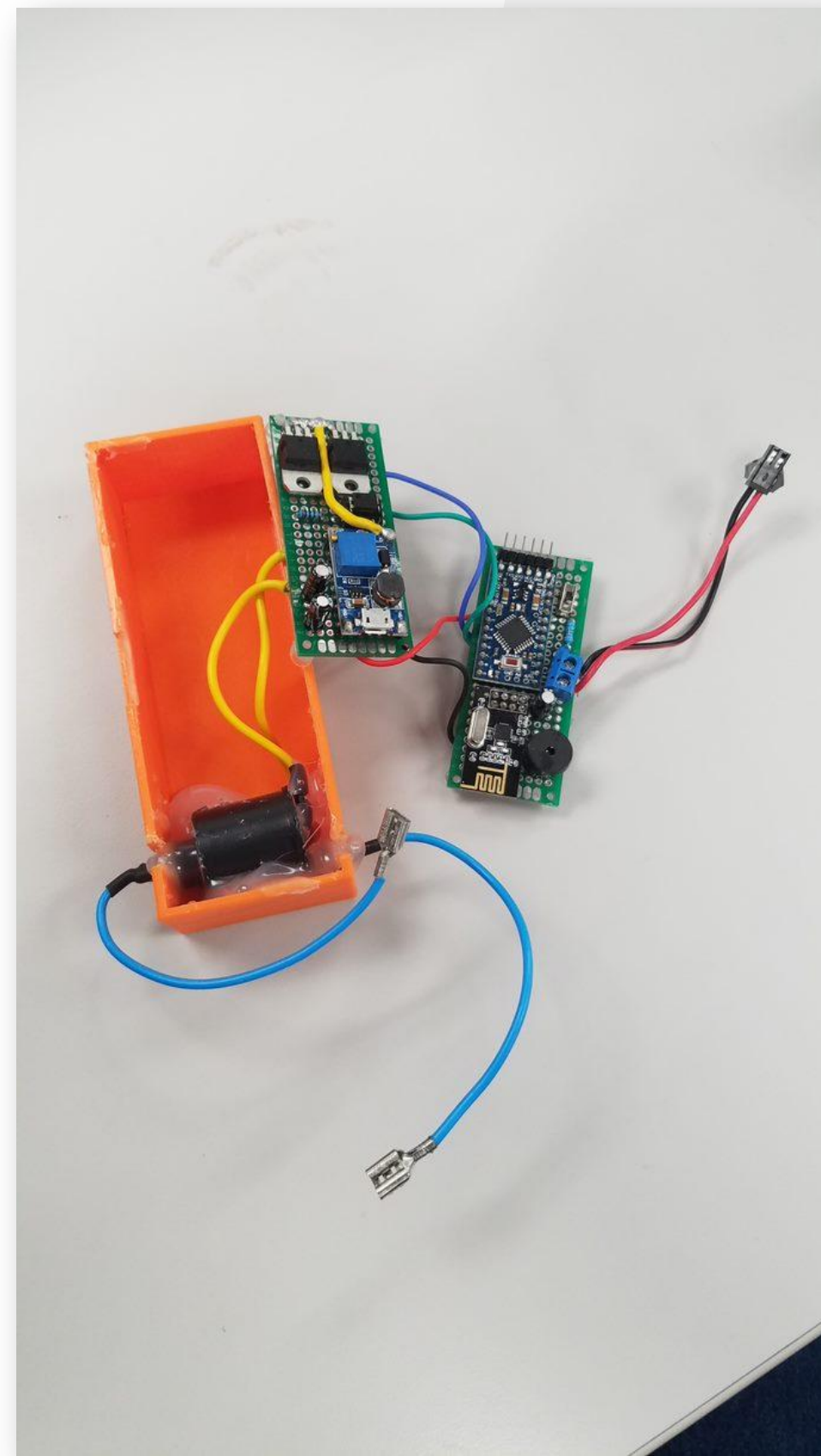
- **Devices send "Blink IDs" (Shown above)**
- **We need to parse the ID2, ID2 and distance**
- **Can send commands over the air to remote devices**

# NANOTRON PROGRAM

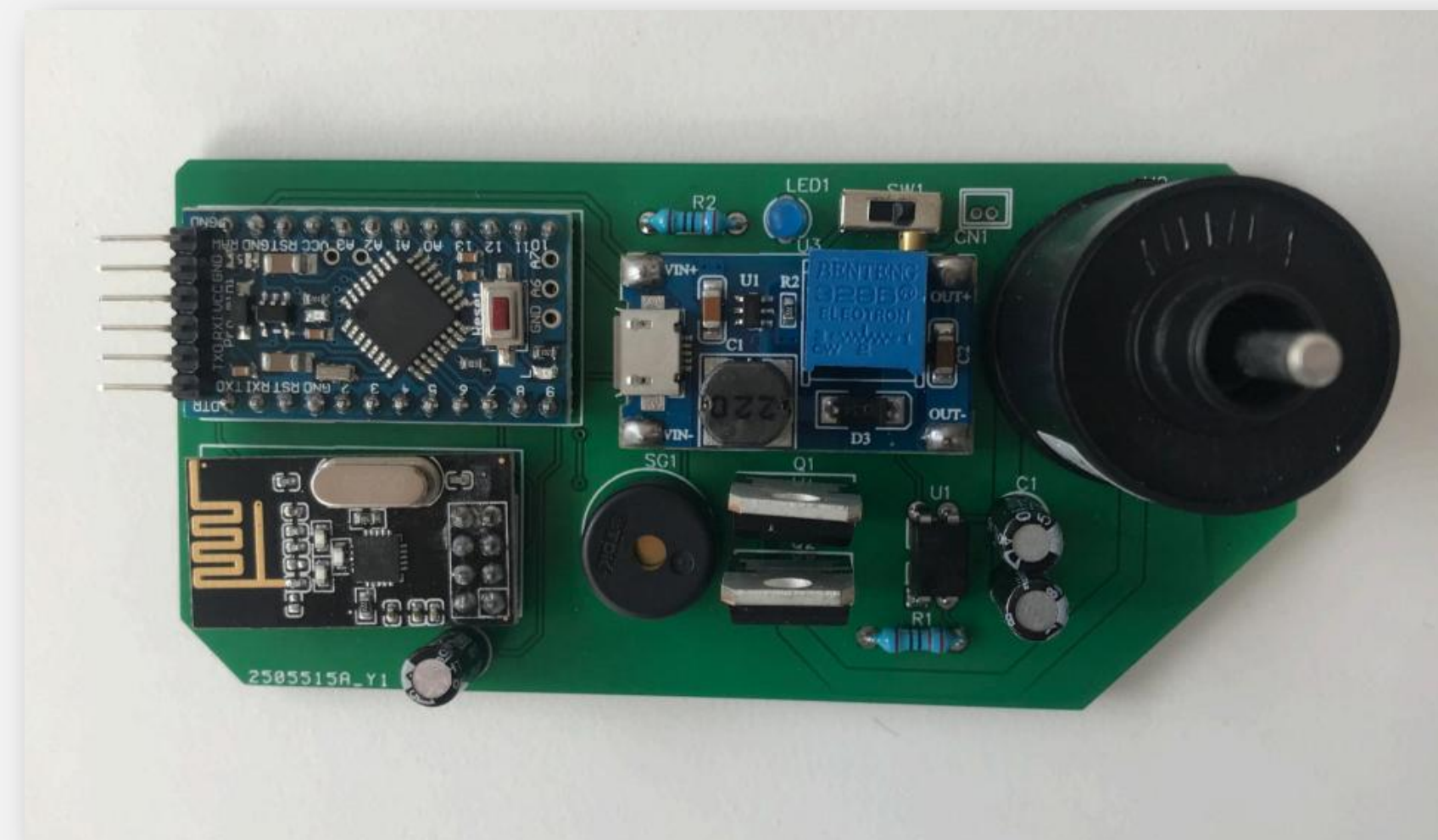
```
*RRN:0000025DEE6B,0000112A7CCA,0,000176,0004,-35
ID1 = 0000025DEE6B
ID2 = 0000112A7CCA
distance = 000176 centimeters
RSSI = -35
this is cow: 0
this is beacon: 3
Hello from cow_distance
Beacon 3 to Cow Success!!!
beacon 3 distance is: 1.84
```



# PCBS



Version 1



Version 2



Version 3

# FIELD TEST

- 3 or 4 beacons
- 1 "cow"
- Potential to use Coax Cable and high gain antennae to improve range



# SWITCH

To reduce costs, we plan to use fewer Nanotron devices to achieve the same goal

- **1 Nanotron device with switch**
- **2 antennae**
- **Time multiplexing to switch between both**
- **The beacons should have two antennas that are at least 5 meters away**



Case Style: QV2426

Connectors	Order P/N
SMA	ZSW2-63DR+
	ZSW2-63DRB+ (with bracket)



# BOM/BUDGET

FOR FALL 2019-SPRING 2020

## Permanent Beacon: (x4)

Nanotron Kit- \$215

Arduino Mega - \$15

USB mini cords - \$2

Hardware \$45

## Totals:

$\$277 \times 4 = \$1108$

## Cow Devices: (x4-5)

Shock Circuit PCBs (with all parts) - \$20

Nanotron Module - \$50

Physical Ear Tag Materials - \$2

$\$72 \times 4 = \$288$

## Visual Beacons: (x10)

Hardware (reflective post) \$2

$\$2 \times 10 = \$20$

**Total : \$1416**

# TIMELINE

